**Dissemination of Education for Knowledge, Science and Culture"**

**- Shikshanmaharshi Dr. Bapuji Salunkhe**

**Shri Swami Vivekanand Shikshan Sanstha's**

# Vivekanand College, Kolhapur (Empowered Autonomous)

*DEPARTMENT OF CHEMISTRY*

**Two Years PG Programme**

**Department/Subject Specific Core or Major (DSC)**

# Curriculum, Teaching and Evaluation Structure

**As Per NEP 2020**

**For**

## M. Sc. II Inorganic Chemistry

**Semester-III & IV**

**SYLLABUS**

**to be implemented from Academic Year 2024-25**

# VIVEKANAND COLLEGE, KOLHAPUR
# (EMPOWERED AUTONOMOUS)
# DEPARTMENT OF CHEMISTRY
## Syllabus for the Master of Science in Chemistry
## M. Sc. II Inorganic Chemistry (Sem. III & IV)
## (National Education Policy 2020)
## Applicable From Academic Year: 2024 – 2025

1. **Title**: M. Sc. Chemistry, Vivekanand College, Kolhapur (Empowered Autonomous)
2. **Faculty**: Faculty of Science and Technology.
3. **Year of Implementation**: For M. Sc. II (Semester III and Semester IV): From July 2024.
4. **Programme Outcomes (POs):** After completing the M. Sc. Programme, the students will able to:

| | |
|---|---|
| **PO 1:** | **Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the concerned discipline and execute theoretical and practical understanding |
| **PO 2:** | **Research-related skills and Scientific temper:** Infer scientific literature and formulate hypothesis for research problems; plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct, and creating awareness about intellectual property rights and issues of plagiarism. |
| **PO 3:** | **Entrepreneurship Development:** Apply acquired knowledge to build entrepreneurship |
| **PO 4:** | **Environment and Sustainability:** Understand the impact of scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development. |
| **PO 5:** | **Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes. |

5. **Programme Specific Outcomes (PSOs):** After completing the M. Sc. Programme in Chemistry, the students will able to:

**PSO1:** Demonstrate, solve, and understand major concepts in all disciplines of chemistry.

**PSO2:** Think methodically, and independently, and draw a logical conclusion of chemistry.

**PSO3:** Employ critical thinking and scientific knowledge to design, carry out, record, and analyze the results of chemical reactions.

**PSO4:** Create an awareness of the impact of chemistry on the environment, society, and development outside the scientific community.

**PSO5:** To inculcate the scientific temperament in the students and outside the scientific community.

**PSO6:** Use modern techniques, decent equipment, and various chemistry software.

**VIVEKANAND COLLEGE, KOLHAPUR (EMPOWERED AUTONOMOUS)**

# Department of Chemistry

## Departmental Teaching and Evaluation Scheme

**Two - Years PG Programme**

**Department/Subject Specific Core or Major (DSC) (as per NEP-2020 Guidelines)**

## Inorganic Chemistry

## First Year Semester - I & II

| Sr. No. | Course Abbr. | Course code | Course Name | Teaching Scheme Hours/week | | Examination Scheme and Marks | | | | Course Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | TH | PR | ESE | CIE | PR | Marks | |
| **Semester - I** | | | | | | | | | | |
| 1 | DSC-I | DSC15CHE11 | Inorganic & Organic Chemistry | 4 | - | 80 | 20 | - | 100 | 4 |
| 2 | DSC-II | DSC15CHE12 | Physical & Analytical Chemistry | 4 | - | 80 | 20 | - | 100 | 4 |
| 3 | DSE-I | DSE15CHE11 | Inorganic Chemistry | 4 | - | 80 | 20 | - | 100 | 4 |
| | DSE-II | DSE15CHE12 | Organic Chemistry | | - | | | - | | |
| | DSE-III | DSE15CHE13 | Physical Chemistry | | - | | | - | | |
| | DSE-IV | DSE15CHE15 | Analytical Chemistry | | - | | | - | | |
| 4 | RMD-I | RMD15CHE11 | Research Methodology | 4 | - | 80 | 20 | - | 100 | 4 |
| 5 | DSC-PR-I | DSC15CHE19 | Chemistry Lab-I | - | 12 | | - | 150 | 150 | 6 |
| | | | **Total** | **16** | **12** | **320** | **80** | **150** | **550** | **22** |
| **Semester - II** | | | | | | | | | | |
| 1 | DSC-III | DSC15CHE21 | Inorganic & Organic Chemistry | 4 | - | 80 | 20 | - | 100 | 4 |
| 2 | DSC-IV | DSC15CHE22 | Physical & Analytical Chemistry | 4 | - | 80 | 20 | - | 100 | 4 |
| 3 | DSE-V | DSE15CHE21 | Inorganic Chemistry | 4 | - | 80 | 20 | - | 100 | 4 |
| | DSE-VI | DSE15CHE22 | Organic Chemistry | | - | | | - | | |
| | DSE-VII | DSE15CHE23 | Physical Chemistry | | - | | | - | | |
| | DSE-VIII | DSE15CHE24 | Analytical Chemistry | | - | | | - | | |
| 7 | FPR-I | FPR15CHE21 | Field Project (OJT) | - | 4 | - | - | - | 100 | 4 |
| 8 | DSC-PR-II | DSC15CHE29 | Chemistry Lab-II | - | 12 | - | - | 150 | 150 | 6 |
| | | | **Total** | **12** | **16** | **240** | **60** | **150** | **550** | **22** |
| | **Total (Sem. I & II)** | | | **28** | **28** | **560** | **140** | **300** | **1100** | **44** |

# Second Year Semester - III & IV

| Sr. No. | Course Abbr. | Course code | Course Name | Teaching Scheme Hours/week | | Examination Scheme and Marks | | | | Course Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | TH | PR | ESE | CIE | PR | Marks | |
| **Semester - III** | | | | | | | | | | |
| 1 | DSC-V | DSC15CHE31 | Inorganic Chemical Spectroscopy | 4 | - | 80 | 20 | - | 100 | 4 |
| 2 | DSC-VI | DSC15CHE32 | Coordination Chemistry-I | 4 | - | 80 | 20 | - | 100 | 4 |
| 3 | DSE-IX | DSE15CHE31 | Material Science | 4 | - | 80 | 20 | - | 100 | 4 |
| | DSE-X | DSE15CHE32 | Nuclear Chemistry | | | | | | | |
| 4 | DSC-PR-III | DSC15CHE39 | Chemistry Lab-III | - | 12 | | - | 150 | 150 | 6 |
| 5 | RPR-I | RPR15CHE31 | Research Project | - | 4 | - | - | - | 100 | 4 |
| | | | | **12** | **16** | **240** | **60** | **150** | **550** | **22** |
| **Semester-IV** | | | | | | | | | | |
| 1 | DSC-VII | DSC15CHE41 | Instrumental Techniques | 4 | - | 80 | 20 | - | 100 | 4 |
| 2 | DSC-VIII | DSC15CHE42 | Coordination Chemistry-II | 4 | - | 80 | 20 | - | 100 | 4 |
| 3 | DSE-XI | DSE15CHE41 | Inorganic Nanomaterials | 4 | - | 80 | 20 | - | 100 | 4 |
| | DSE-XII | DSE15CHE42 | Energy and Environmental Chemistry | | | | | | | |
| 7 | DSC-PR-IV | DSC15CHE49 | Chemistry Lab-IV | - | 4 | - | - | 100 | 100 | 4 |
| 5 | RPR-II | RPR15CHE41 | Research Project | - | 6 | - | - | - | 150 | 6 |
| | | | | **12** | **10** | **240** | **60** | **100** | **550** | **22** |
| | **Total (Sem. III & IV)** | | | **24** | **26** | **480** | **120** | **250** | **1100** | **44** |

**Abbreviations:** TH-Theory, PR-Practical, RPR- Research Project, SEE- Semester End Examination, DSC- Discipline Specific Core, CIE-Continuous Internal Examination

**Note:** Minimum passing for 20 marks Internal evaluation = 08 marks
Minimum passing for 80 marks Theory paper = 32 marks
Minimum passing for 150 marks Practical = 60 marks

**Separate passing for each Head - SEE, CIE and Practical**

# Vivekanand College, Kolhapur (Empowered Autonomous)
## M. Sc. Part - II (Inorganic Chemistry)
## Semester - III
## CH.301: DSC-V: Major Paper: Inorganic Chemical Spectroscopy (DSC15CHE31)

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**Course Outcomes: After the completion of the course, the student will be able to:**

**CO1:** Interpret the symmetry elements and their operations as required to specify molecular symmetry and possible point groups from symmetry elements and be able to find point group of molecules by systemic procedure.

**CO2:** Explain the principle and instrumentation of infra-red (IR) and Raman spectroscopy and interpret infrared and Raman spectra for chemical analysis inorganic compounds.

**CO3:** Explain the principle and instrumentation of Mass spectroscopy and interpret Mass spectrum for chemical analysis of inorganic compounds.

**CO4:** Explain the principle and instrumentation of nuclear magnetic resonance (NMR) and X-ray photoelectron spectroscopy (XPS) and interpret the spectrum for chemical analysis of inorganic compounds.

| Unit No. | Syllabus | No. of Lectures |
|---|---|---|
| **Unit I:** | **Molecular Symmetry and Group Theory**<br>Introduction to symmetry, Symmetry operations, Symmetry elements, Point group and its classification (Cn-type, Dn-type and Special-type), Schoenflies symbol for point groups, Determination of point group for $AB_2$ (Bent), $AB_3$ (Trigonal pyramid), $AB_3$ (Trigonal Planar), $AB_4$ (Square planar), $AB_5$ (Trigonal bipyramidal), $AB_6$ (Octahedral), $CO_2$, HCl, CO, ortho–, meta– and para–disubstituted benzene molecules. Symmetry, dipole moment and optical activity of molecules, Group and its properties, Group multiplication table, Matrix representation of symmetry elements. | **15 Hrs** |

| | | |
|---|---|---|
| **Unit II:** | **IR and Raman Spectroscopy**<br>**A) Infrared spectroscopy:**<br>Principle of IR Spectroscopy, Instrumentation: principle and working, The diatomic vibrating rotator, Vibration– rotation spectrum of carbon monoxide, The vibration of polyatomic molecules, The influence of rotation of the spectra of polyatomic molecules, Applications of IR Spectroscopy.<br>**B) Raman spectroscopy:**<br>Raman Scattering, Raman Spectrometer: Fourier Transform Raman Spectrometer, Classical and quantum theory, Pure rotational and vibrational Raman spectra, Rule of mutual exclusion, Overtone and combination vibrations, Rotational fine structure, Modes of vibrations, Applications, Selection rules for Infrared and Raman spectra, Structure determination using IR and Raman Spectroscopy. | **7 Hrs**<br><br>**8 Hrs** |
| **Unit III:** | **Mass Spectroscopy**<br>Basic principle, Instrumentation, Electron-impact and induced ionisation, Fast Atom Bombardment (FAB) spectrometry, Qualitative and semiquantitative theories including QET, Concept of metastable ions transitions, Stevensons's rules, Applications for metal compounds containing carbonyl, alkyl, cyclopentadienyl and acetylacetonate. | **15 Hrs** |
| **Unit IV:** | **NMR and X-ray Photo electron Spectroscopy (XPS)**<br>**A) NMR Spectroscopy:**<br>Principle, Instrumentation of NMR, Chemical shift, Shielding and deshielding, Spin-spin splitting, Applications of spin coupling for structural determination, Double resonance techniques, The contact and pseudo contact shifts, Factors | **8 Hrs** |

| | | |
|---|---|---|
| | affecting nuclear relaxation, Overview of NMR of metal nucleus of $^{195}Ag$ &$^{119}Sn$, Applications of solid-state NMR technique.<br>**B) X-ray Photo electron Spectroscopy (XPS):**<br>Introduction and basic theory, Instrumentation, Chemical Shifts and oxidation states, Spectral analysis, Argon ion sputtering technique, Applications of XPS. | **7 Hrs** |

**Reference Books:**


1. K. Burger, Coordination Chemistry-experimental methods, Butterworth's
2. R. Drago: Physical method in Inorganic Chemistry, DUSAP.
3. B. K. Sharma, Instrumental methods of chemical analysis.
4. Gurudeep Chatwal and Shyam Anand, Instrumental methods of chemical analysis.
5. Hill & Day advanced methods in Inorganic Chemistry, J.Weily
6. F.A. Cotton, chemical application of group theory, Weily eastern
7. Figgis, Introduction to ligand field theory field
8. Schaefer & Gilman: Basic principles of ligand field Theory, J. Wiely
9. P.R. Backer: Molecular symmetry and Spectroscopy A.P.
10. Ferraro Ziomeek, Introduction to Group theory, plenum
11. Scotland Molecular symmetry DVN
12. Dorian: symmetry in Chemistry EWAP
13. Hall: Group theory and symmetry in Chemistry MGLt
14. Nakamoto Infrared R Raman Spectra of Inorganic & Coordination compounds, J. Weily
15. Nakanisha: Spectroscopy and structure J. Weily
16. Ferroro: Metal ligand and related vibrations
17. CNR Rao Spectroscopy in Inorganic Chemistry Vol I, II, III
18. Durie: vibrations spectra and structure Vol. I to IV, Elsevier
19. Dudd, chemical Spectroscopy Elsevier
20. Popel: H.N.M.R. Spectroscopy J. Weily
21. R.J. Abraham, J. Fisher and P Loftus Wiley Introduction to NMR spectroscopy.

22. P.K. Bhattacharya: Group Theory & Its Chemical Applications
23. K.V. Reddy: Symmetry & spectroscopy of Molecules.
24. M. R. Litzow and T R Spelding, Mass Spectroscopy of Inorganic & Organometallic Compounds, Elsevier, 73.

## M. Sc. Part - II (Inorganic Chemistry) Semester – III
## CH.302: DSC-VI: Major Paper: Co-ordination Chemistry-I
## (DSC15CHE32)

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**Course Outcomes: After the completion of the course, the student will be able to:**

**CO1:** Know the fundamentals in photochemistry, to explain different types of photochemical reactions and photochemistry of coordination compounds.

**CO2:** Understand Orgel diagrams and explain electronic spectra of transition metal complexes.

**CO3:** Understand Magnetic properties of Complexes and explain with respect to spin orbit coupling.

**CO4:** Understand and explain mixed ligand complexes and use of transition metal complexes in catalysis.

| Unit No. | Syllabus | No. of Lectures |
|---|---|---|
| **Unit I:** | **Photochemistry of Metal Complexes**<br>Absorption, Excitation, Photochemical laws, Quantum yield, Electronically excited states of Metal complexes, Types of photochemical reactions; substitution reactions, rearrangement reactions and redox reactions, Photochemistry of coordination compounds, Charge transfer spectra, Charge transfer excitations, Methods for obtaining charge transfer spectra. | **15 Hrs** |

| | | |
|---|---|---|
| **Unit II:** | **Electronic spectra of Transition Metal complexes**<br>Determining the Energy terms, Spin-orbit (L-S) coupling scheme, Hund's rule, Derivation of the term symbol for a $d^1$ to $d^9$ configuration, Electronic spectra of transition metal complexes – Laporte 'orbital' selection rule, spin selection rule, Orgel diagrams for octahedral metal parameters for octahedral complexes, Racah parameters, calculations of 10 Dq, B and β complexes of cobalt and nickel, Tanabe-Sugano diagrams for octahedral complexes, Charge transfer spectra, Selection rule and charge transfer spectra. | **15 Hrs** |
| **Unit III:** | **Magnetic Properties of Transition Metal Complexes**<br>Introduction, Types of magnetic behaviour, Diamagnetism, Origin of paramagnetism, Temperature dependent paramagnetism, Spin-orbit interaction, Pascal constants, Ferromagnetism and antiferromagnetism of metal complexes, Van Vleck's equation: derivation and applications, Spin orbit coupling and magnetic moment, Spins crossover phenomenon, Determination of magnetic susceptibility. | **15 Hrs** |
| **Unit IV:** | **Mixed Ligand Complexes and Catalysis of Transition Metal Complexes**<br>**A] Mixed ligand complexes**<br>Stabilities and dynamics of formation of ternary complexes, Reaction of coordination ligand in ternary complexes, Mimicking reactions in biological systems, Enzyme models, Amino acids, ester hydrolysis, Peptide synthesis and its hydrolysis, Detarbodylation of β keto acids.<br>**B] Catalysis of transition metal complexes**<br>Introduction, General principle, Catalysis by transition metal complexes, Oxidation of hydrocarbons by $O_2$, Oxidation, | **7 Hrs**<br><br>**8 Hrs** |

| | | |
|---|---|---|
| | polymerization and hydrogenation of olefins, Metal complex catalyzed reactions of arenes, Catalysis in condensation polymerization, Current and future trends in catalysis. | |

**Reference Books:**


1. Pimpalapure, Jain and shaha, Coordination Chemistry
2. B. R. Puri, L.R. Sharma and K. C. Kalkiya, Principles of Inorganic Chemistry.
3. A. K. Das, Inorganic Chemistry.
4. K. K. Rastogi and Mukharjee, Fundamentals of Photochemistry, Wiley eastern.
5. J. G. Calverts and J. N. Pits, Photochemicals of Photochemistry, John Wiley.
6. Wells, Introduction to 4Photochemistry.
7. V. Balzani& V. Cavassiti, Photochemistry of Coordination compounds, AP, London, 1970. 5. Comprehensive Coordination Chemistry, Vol.1. G Wilkinson (Ed) Wiley, New York, 1967.
6. Inorganic Chemistry by J.E. Huheey, E.A. Keiter and R.L. Keiter 4th edn. Harper Collins, 1993
7. Mechanisms of Inorganic Reactions, by C.F. Basolo and R.G. Pearson, Wiley, New York, 1967
8. Earnshaw: Introduction to Magneto Chemistry

9 Mabbs & Machin Magnetism & transition metal complexes Chamman hall

10. Calvin, Magnetic properties of transition metal complexes.
11. L.N. Maley: Magneto Chemistry
12. Datta & Shymlal: Elements of Magneto Chemistry
13. James E. Huheey: Inorganic Chemistry Principles of Structure and reactivity, Harber & Row, Publishers Inc. New York 1972.
14. K.P. Purcell & J.C. Kote: An Introduction to Inorganic Chemistry Holt Sounders, Japan 1980.
15. William L. Jolly: Modern Inorganic Chemistry, Mecgrow Hill USA,1984
16. F.A. Cotton & R.G. Willkinson: Advanced Inorganic Chemistry.

# M. Sc. Part - II (Inorganic Chemistry) Semester – III
# Elective Paper (Students can select any one paper from following)
# DSE - IX: Elective Paper I: Material Science
# (DSE15CHE31)

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**Course Outcomes: After the completion of the course the student will be able to:**

**CO1:** Adopt knowledge about bonding in crystals and various types of structures.

**CO2:** Explain mechanism of superconductors, classify super conductors, explain BCS theory of superconductivity and know the applications of different materials

**CO3:** Explore new areas of research in both ceramics and composite materials manufacturing.

**CO4:** Understand and apply core principles and concepts in catalysis using different inorganic complexes as catalyst.

| Unit No. | Syllabus | No. of Lectures |
|---|---|---|
| **Unit I:** | **Solid State Materials**<br>A) Bonding in crystals, Crystal systems and Bravais Lattice, Lattice planes and their designation. Metallic Crystal structures: Face-centered cubic (fcc), body-centered cubic (bcc), hexagonal close-packed (hcp) structure. Radius ratio rule (2, 3, 4, 6, 8 co–ordinate structures), octahedral and tetrahedral voids, Isomorphism and polymorphism, Numericals.<br>B) Simple type structures: AB type: NaCl, CsCl, Zinc sulphide (sphalerite or cubic and hexagonal) , $AB_2$ type: Fluorite ($CaF_2$), $TiO_2$ (Rutile), $CaC_2$, $CdI_2$ structures, $AB_3$ type: $ReO_3$, $BiI_3$, $A_2B_3$ type: Corundum $Al_2O_3$, α-$Fe_2O_3$, $Mn_2O_3$, $ABO_3$ type: Perovskite Structures (Barium titanate, lead titanate, $CaTiO_3$, $FeTiO_3$), $AB_2O_4$ type - Spinel structure, Normal & Inverse, Factors causing distortion in spinel, $A_2B_2O_7$ type: Pyrochlores ($La_2Sn_2O_7$) | **15 Hrs** |

| | | |
|---|---|---|
| **Unit II:** | **Superconductivity Materials, Crystal defects and Non stoichiometry**<br>**A] Superconductivity materials:** Introduction, Superconductivity, Critical temperature, Critical field, BCS theory, Properties and classification of superconductors, High Tc superconductors; examples with structure and applications, Fullerenes, Intermetallic superconductors; synthesis, applications.<br>**B] Crystal defects and non-stoichiometry:** Point defects: vacancies, interstitials, impurities, expression for schottky and frenkel defects. Line defects: edge and screw dislocation. Stacking faults in grain boundaries, Phase transformation in solids, Solid state reactions and crystal growth, Preparation methods of solids. | **15 Hrs** |
| **Unit III:** | **Magnetic Materials**<br>Introduction, Atomic magnetism and solids, Types of magnetic materials, Exchange interactions, Magnetic order (Ferro, Antiferro and Ferri), Hysteresis loop and their classification, Calculation of magnetic moment from saturation magnetization, Magnetic domains, Examples of magnetic materials, Soft and hard ferrites, Structure and magnetic interactions in spinel, Garnet hexagonal ferrites, Application of magnetic materials | **15 Hrs** |
| **Unit IV:** | **Homogeneous Catalysis**<br>Introduction, General features of catalysts, Types of catalysts, Catalytic steps, classification, theories of catalysis, Industrial applicationss, Catalytic reactions of coordination and organometallic compounds including polymerization activation of small molecules, addition to multiple bonds, | **15 Hrs** |

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|---|---|---|
| | hydrogenation, Zeigler-Natta polymerization of olefins, monsanto acetic acid process. | |

**Reference Books:**


1. B. R. Puri, L.R. Sharma and K. C. Kalkiya, Principles of Inorganic Chemistry.
2. Dr. Indrajeet Kumar, Organometallic Compounds.
3. Solid state Chemistry: An Introduction – L.E. Smart & E.A. Moore, CRC, Taylor & Francis, 3rd Edn.
4. Materials Science & Engineering – V. Raghvan, 2nd Edn.
5. Introduction to Solids – L.V. Azarroff, 2nd Edn. 1980
6. Elements of materials science and engineering – Van Vleck, 5th Edn.
7. Insight to Speciality Inorganic Chemicals – D. Thompson, Royal Society of Chemistry, 1995.

# M. Sc. Part - II (Inorganic Chemistry) Semester – III
# DSE - X: Elective Paper II: Nuclear Chemistry
# (DSE15CHE32)

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**Course Outcomes: After the completion of the course the student will be able to:**

**CO1:** Understand types of radioactive decay, natural decay series, nuclear models, nuclear properties, Mass energy, relationships, nuclear reactions, rates of radioactive decay, interaction of radiation with matter.

**CO2:** Explain nuclear structure and stability, define binding energy and mass defect and calculate each for a given nucleus, understand nuclear models to understand nuclear structure and their properties.

**CO3:** Identify and define various types of nuclear changes or processes including fission, fusion and decay reactions, to understand nuclear reactions and mechanism behind that.

**CO4:** Understand the basics of nuclear chemistry applications: nuclear power, nuclear reactor, medical treatment, isotopic labelling, and carbon dating.

| Unit No. | Syllabus | No. of Lectures |
|---|---|---|
| **Unit I:** | **Systematic Study of Alpha, Beta and Gamma Decays**<br>Alpha, beta and gamma decay, Energy curve, Spectra of alpha and beta particles, Giger Nuttal law, Theory of alpha decay, Penetration of potential barrier, Range of energy relationship, Sergeants curve, Fermi theory of beta decay, Matrix elements, Allowed and forbidden transitions, Curie plots, Nuclear energy levels, Selection rule isomeric transitions, Internal conversion, Auger effect. | **15 Hrs** |

| | | |
|---|---|---|
| **Unit II:** | **Nuclear Structure and Stability**<br>Binding energy, Empirical mass equation, Nuclear models; liquid drop, Single particle shell, Fermi gas and collective/lunified nuclear models, Nuclear spin, Parity and magnetic moments of odd mass number nuclei, numerical problems. | **15 Hrs** |
| **Unit III:** | **Nuclear Reactions and Nuclear Fission**<br>Introduction, Production of projectiles, Nuclear cross section, Nuclear dynamics, Threshold energy of nuclear reaction, Coulomb scattering, Potential barrier, Potential well, Formation of a compound nucleus, Nuclear reactions; direct nuclear reactions, heavy ion induced nuclear reactions and photonuclear reactions. Liquid drop model of fission, Fission barrier and threshold, Fission cross section, Mass energy and charge distribution of fission products, Symmetric and asymmetric fission, Decay chains and delayed neutrons. | **15 Hrs** |
| **Unit IV:** | **Reactor Theory and Applications of Radioactivity**<br>Nuclear fission as a source of energy, Nuclear chain reacting systems, Critical size of a reaction, Research reactors; graphite moderated, enriched uranium, light water moderated, heterogeneous, aqueous homogeneous reactors and thermonuclear reactors, Gamma interactions, Shielding and health protection, Reactors in India, Tracer techniques; structure determination, elucidation of reaction mechanism, isotopic dilution analysis, neutron activation analysis, applications in biological, medical, industrial fields and age determination. | **15 Hrs** |

**Reference Books:**


1. Friedlander, Kennedy and Miller, Nuclear and Radio Chemistry: John Wiley
2. B. G. Harvey, Nuclear Chemistry
3. Hassinsky: Translated by D. G. Tuck, Nuclear Chemistry and its application: Addison Wiley
4. B.G. Harvey, Introduction to Nuclear Physics and Chemistry
5. Maeclefort: Nuclear Chemistry: D. Van Nostrand
6. An N. Nesmeyannoy: Radiochemistry: Mir
7. Jacobs et al: Basic Principles of nuclear Science and Reactors, V. Nost & EWAP
8. N. Jay: Nuclear Power Today Tomorrow: ELBS
9. Kenneth: Nuclear Power Today, Tomorrow: ELBS
10. Essentials of Nuclear Chemistry, W. J. Arnikar, John Wiley
11. Nuclear and Radiation Chemistry: B. K. Sharma, Krishna Publication 12
12. A Introduction to Nuclear Physics: R. Babber. And Puri.
13. Essential of Nuclear Chemistry by H. J. Arnikar

# M. Sc. Part - II (Semester - III) Inorganic Chemistry Practical Course
# DSE – PR-III: Chemistry Lab - III
# (DSC15CHE39) (Credits 4+2)

## I] Non-Instrumental

### A] Analysis of Ores and Alloys (Any two)

1. **Ore Analysis –** Bauxite and Galena Ore
2. **Alloy Analysis –** Bronze and Stainless Steel alloy

## II] Instrumental Experiments

### B] Spectrophotometry (Any two)

1. To study the spectra and determine extinction coefficient of potassium permagnate and potassium dichromate.
2. To determine chromium and manganese simultaneously.
3. To determine the PKa value of Methyl red indicator by using spectrophotometer

### C] Inorganic Preparations (Any two)

1. Preparation and determination of percentage purity of [tris-(acetyl-acetanato) ferrate III]
2. Preparation and determination of percentage purity of [ammonium tetrathiocyanato diamminochromate(III)]
3. Preparation and determination of percentage purity [Carbonato tetraamine cobalt(III)]
4. Preparation and determination of percentage purity [Potassium trioxalato ferrate (III)]

### D] pH metry(Any one)

1. To Determine Dissociation constant of ethylene diammine.
2. To Determine Dissociation constant of Carbonic acid.

### E] Conductometry (Any one)

1. To study the titration between acidified aluminium and NaOH.
2. To titrate the mixture of nitric acid and sulphuric acid against NaOH.

**Note: Any suitable experiment may be added**

## RPR-I: RPR15CHE31: Research Project

Projects on contemporary issues of societal significance which should include literature survey, synthesis, reaction mechanism and kinetics, analysis of air, water and soil samples, solid state materials, energy generation and storage materials, nanochemistry, green chemistry, organic materials, organo-metallic, bioinorganic materials, novel materials etc. The Project work will be examined jointly by internal and external examiners at the time of practical examination.

**Research Project Paper Guidelines**

1. The students should write a synopsis of the proposed research work.
2. The students should perform a detailed literature survey related to the research problem.
3. The students should write a review article related to the research problem.
4. It is expected to publish the review article in peer-reviewed journals.
5. The students should design the problem and start experimental work. The students should complete at least 25% of their experimental work during semester III and the same work to be continued in semester IV.
6. The student should submit the spiral-bound copy of research work carried out during semester III including the synopsis, research proposal, review article, and certified progress report.
7. The Research Project will be examined jointly by internal and external examiners during the practical examination at the end of the semester.
8. The students should present their work during the evaluation in the form of PowerPoint presentation (PPT).

**Marking Scheme:**

| Sr. No. | Description | Marks |
|---|---|---|
| 1 | Synopsis | 10 |
| 2 | Research Proposal | 20 |
| 3 | Review article on proposed work | 20 |
| 4 | Daily Lab notebook record | 10 |
| 5 | Progress of Experimental work | 20 |
| 6 | Quality and effectiveness of presentation | 20 |
| | **Total** | **100** |

**Broad guidelines for the preparation of synopsis**

**A.** The proposed synopsis for research should be self-contained and should cover the rationale for carrying out research.

**B.** There should not be a repetition of the work topic or theme.

**C.** The synopsis of the proposed research shall contain the following points:

1 Title of the Research Proposal

2 Motivation with reasoning and significance of the proposed research

3 Statement of the problem

4 Review of the relevant literature

1. Objectives of the study
2. The methodology comprising
   - **a)** Methods of research
   - **b)** Sampling design and assumptions
   - **c)** Conceptual framework if any
   - **d)** Research design (explanation of how research is being conducted and the tools used for the same)
   - **e)** Methods of data collection
   - **f)** Methods of data analysis (use of parametric and non-parametric tools and techniques as the case may be)
3. Expected outcome
4. Bibliography.

**Template for Research Proposal**

1. Title
2. Introduction
3. Origin of the research problem
4. Interdisciplinary relevance
5. Review of Research and Development in the Subject
6. Significance of the study
7. Objectives
8. Plan of research work

**Reference Books:**


1. A Text book of Quantitative Inorganic Analysis; A. I. Vogel
2. Practical inorganic chemistry; Pass Geoffrey and haydn Sutcliffe.
3. Advance Inorganic Analysis – S K Agarwala, KeemtiLal , Pragati Prakashan
4. Advanced Practical inorganic chemistry; Gurudeep Raj.
5. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
6. Systematic experimental physical chemistry – T. K. Chondhekar& S.W. Rajbhoj
7. Experiments in chemistry – D.V. Jahagirdar
8. Textbook of quantitative Inorganic Analysis – IV Edn. J. Bassett, R. C. Denny, G.H. Gefery and J. Mendham

# Vivekanand College, Kolhapur (Empowered Autonomous)
## M. Sc. Part - II (Inorganic Chemistry)
## Semester - IV
## CH.401: DSC-VII: Major Paper: Instrumental Techniques
## (DSC15CHE41)

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**Course Outcomes: After the completion of the course, the student will be able to:**

**CO1:** Understand and use various crystallographic databases. Process data, solve/refine and interpret a single crystal structure. Apply the concepts of unit cells and lattices to describe observed diffraction patterns in reciprocal space.

**CO2:** Acquire Knowledge of Nuclear Quadrupole Resonance and X-ray fluorescence spectroscopy and to apply to interpret data.

**CO3:** Understand the principal, instrumentation and apply for structural elucidation and investigation of compounds.

**CO4:** Understand ESR measurements, acquire information about the existence of unpaired electrons, as well as quantities, type, nature, environment and behaviour and to interpret structure.

| Unit No. | Syllabus | No. of Lectures |
|---|---|---|
| **Unit I:** | **X-ray Diffraction Techniques**<br>Introduction, General theory, origin of X – rays, Interaction of X – rays with matter, Principle: Scattering and diffraction, Bragg's equation, Instrumentation, X – ray diffraction methods: Laue photographic method, Bragg's X- ray spectrophotometer method, rotating crystal method and powder method, Application of X – ray diffraction, Identification of compounds using powder diffraction with examples, Significance of intensities, Particle size determination: Spot counting method and broadening of diffraction line, Determination of Cis-trans isomerism, Determination of linkage isomerism. | **15 Hrs** |

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| **Unit II:** | **NQR Spectroscopy and XRF Spectrometry**<br>**A] Nuclear Quadra pole Resonance Spectroscopy [NQR]:**<br>Basic concepts of NQR; Nuclear electric quadruple moment, Electric field gradient, Energy levels and NQR frequencies, Effect of magnetic field on spectra, Factors affecting the resonance signal; line shape and position of resonance signal, Relationship between electric field gradient and molecular structure, Interpretation of NQR data.<br>**B] X-ray Fluorescence Spectrometry (XRF):**<br>Introduction and basic theory, Instrumentation; dispersive systems and detectors, Matrix effects, XRF with synchrotron radiation, Spectral analysis, Analytical information, Elementary theory of recoil free emission and resonant absorption of gamma rays, Applications. | **8 Hrs**<br><br>**7 Hrs** |
| **Unit III:** | **Mossbauer Spectroscopy**<br>Introduction and Basic principles of $^{57}Fe$ Mössbauer spectroscopy, Instrumentation, Mössbauer parameters; recoilless emission and absorption of x-rays, isomer shifts, magnetic dipole hf splitting and electric quadrupole hf splitting, Magnetic hyperfine interaction, Line broadening.Application of Mössbauer spectroscopy with respect to (i) Oxidation states of metal ion in compounds, (ii) Structural elucidation, investigations of compounds of iron and tin, (iii) Covalent and ionic compoundsand (iv) High spin low spin behaviour. | **15 Hrs** |
| **Unit IV:** | **Electron Spin Resonance Spectroscopy**<br>Principle of ESR Spectroscopy, Presentation of spectrum, Hyperfine splitting in proton systems, Rules for evaluating ESR lines of Naphthalene anion radical, Pyrazine anion | **15 Hrs** |

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|---|---|---|
| | radical, Isomers of Xylene anion radicals, $VO_2^+$, Quinoline radical, Isoquinoline radical, Quinoxaline radical, Anthracene radical, Phenanthracne radical, Pyrene radical, Alkyl halide radicals, Quinone and Isoquinone anion radicals, nitrogen/deuterium containing radicals, Superhyperfine splitting, Instrumentation, 'g' value and factors affecting on 'g' value, Zero field splitting, Karmers's degeneracy, Applications, Numericals problems. | |

**Reference Books:**


1. Principles of Instrumental analysis, Skoog, III rd edn., Sounders, 1985
2. Mossbaur Spectroscopy, Greenwood N.N., Gibbs T.C., Chapmann Hall, 1971.
3. Chemical Application of Mossbaur Spectroscopy, Goldanski V.I & Harber R.H., Academic Press 1968.
4. Mössbauer Spectroscopy and Transition Metal Chemistry, P. Gütlich, R. Link, A.Trautwien, Springer-Verlag (1978).
5. Mössbauer Spectroscopy, N.N. Greenwood, T.C. Gibb, Chapman and Hall Ltd. (1971).
6. Instrumental method of analysis (7th edition) By- H.H. Willard, L.L. Merritt. Jr. J.A. Deanand F.A. Settle, Jr (Publisher: CBS Publishers and distributors Pvt .Ltd. (Copyright – wards worth publishing copy USA .2000).
7. Element of X-ray Diffraction - B.D. Cullity (1967)
8. CNR Rao Spectroscopy in Inorganic Chemistry Vol I, II, III
9. Powder Diffraction Theory and Practice, Edited by R E Dinnebier and S J L Billinge, RSC publishing, 2008.
10. In situ X-ray diffraction study of the hydrothermal crystallization of hierarchical $Bi_2WO_6$ nanostructures, Y. Zhou, et al., Nanoscale, 2010, 2, 2412-2417, RSC Publishing Journal.
11. Physical Methods for Chemists, Russel Drago, Surfside Scientific Publishers, 1992

# M. Sc. Part - II (Inorganic Chemistry) Semester – IV
# CH.402: DSC-VIII: Major Paper: Co-ordination Chemistry-II
# (DSC15CHE42)

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**Course Outcomes: After the completion of the course, the student will be able to:**

**CO1:** Explain lability and inertness of complexes and with respect to VBT and CFT.

**CO2:** Explain the kinetics and mechanism of substitution and electron transfer reactions in octahedral and square planar complexes.

**CO3:** Explain methods of properties, preparation, stability and applications of organometallic compounds in organic synthesis.

**CO4:** Interpret structure and bonding transition metal pi-complexes and their applications in organic synthesis relating to nucleophilic and electrophilic attack on ligands.

| Unit No. | Syllabus | No. of Lectures |
|---|---|---|
| **Unit I:** | **Inorganic Reaction Mechanism**<br>Types of mechanisms: Basic concepts, as stability and lability, stability constants; HSAB principle, chelate effect, macrocyclic effect, Ligand and electron transfer reactions in coordination compounds, Intimate and stoichiometric mechanism of ligand substitution. Substitution in square planar complexes: trans effect, trans series, applications of trans effect, Electron transfer reactions: Potential energy diagrams as a conceptual tool, Marcus equation, Types and factors affecting electron transfer reactions. | **15 Hrs** |

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|---|---|---|
| **Unit II:** | **Reaction Mechanism of Transition Metal Complexes**<br>Substitution reaction, Reactions of transition metal complexes, kinetics and mechanism of substitution reactions of octahedral complexes, Stereochemical aspects of substitution reaction of octahedral complexes: Stereochemical changes in dissociation ($SN^2$) and displacement ($SN^2$) mechanism through various geometries of coordination compounds, Isomerization and racemization reactions in octahedral complexes. Steric effects on substitutions. | **15 Hrs** |
| **Unit III:** | **Organo transition Metal Chemistry**<br>**A] Alkyls and Aryls of Transition Metals:** Types, Routes of synthesis, Stability and decomposition pathways, Organocopper compounds of alkyls and aryls in synthesis.<br>**B] Compounds of Transition Metal:** Metal-carbon multiple bonds: Alkylidenes, alkylidynes, low valent carbenes and carbines, Synthesis, Nature of bonds, Structural characteristics, Nucleophilic and electrophilic reactions on ligands, Applications in organic synthesis. | **15 Hrs** |
| **Unit IV:** | **Transition Metal π-Complexes**<br>Metal-carbon multiple bonds, Nature of bonding, Structural characteristics and Synthesis, Properties of transition metal π-complexes with unsaturated organic molecules: alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, Applications of transition metal πcomplexes and their intermediates in organic synthesis relating to nucleophilic and electrophilic attack on ligands. | **15 Hrs** |

**Reference Books:**


1. R. Gopalan and V. Ramlingam: Concise Coordination Chemistry.
2. J. E. Huheey, Ellen A. Keiter and Okhil K. Medhi: Inorganic Chemistry: Principle of Structure and Reactivity.
3. A.K. Das and M. Das, Fundamental Concepts of Inorganic Chemistry, Vol. 1 to Vol. 7, CBS Publishers.
4. F. Basolo and R. Pearsons: Mechanism of Inorganic Reactions: A Study of Metal Complexes in Solution.
5. Obe, M. L. Inorganic reaction mechanism, Nelson, London, 1972.
6. Taube, Electron transfer reactions of metal complex ions in solution. Academic Press.
7. E. S. Gould, Inorganic Chemistry.
8. K. Burger, Coordination Chemistry Experimental methods, Butterworths.
9. Heterogeneous catalysis 2nd edn. Bond C. Chapman all (1987).
10. The application & Chemistry of catalysis by suitable transition metal complexes Parashall. W. Weily N. 1980.
11. Homogeneous transition metal catalysis, A general art, Masters C. Chapman and Hall, London 1981.
12. Introduction to the principles of heterogeneous catalysis, Thomas J.M., Thomas W.J.
    Academic press N.Y. 1967.
13. K. M. Macky, R. A. Macky, Modern Inorganic Chemistry, 4th edn., Blackie, London1989.
14. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Vallabh Publications, Delhi,2005.

# M. Sc. Part - II (Inorganic Chemistry) Semester – IV
# Elective Paper (Students can select any one paper from following)
# DSE - XI: Elective Paper I: Inorganic Nanomaterials
# (DSE15CHE41)

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**Course Outcomes: After the completion of the course the student will be able to:**

**CO1:** Understand synthesis approaches of nanomaterials and challenges in Nano Technology.

**CO2:** Describe different characterization techniques of materials, outline the principles on which they are based, and explain their limitations.

**CO3:** Understand the technological application of nanomaterial is usable in multiple sectors, from healthcare and mechanics to environmental preservation and air purification.

**CO4:** Acquire knowledge about the toxicity in Nanoscience, and their effects on Human as well as learn various concepts of toxicity, and its effects.

| Unit No. | Syllabus | No. of Lectures |
|---|---|---|
| **Unit I:** | **Advanced Synthetic Methods of Inorganic Nanomaterials**<br>General Introduction to Nanomaterials, Nanoscience and nanotechnology, History, Chemical bath deposition: ionic and solubility products, preparation of binary semiconductors, Electrodeposition: Deposition mechanism and preparation of compound thin film, successive ionic layer adsorption reaction method (SILAR), Co-precipitation, Micelles-microemulsions, Reduction method. | **15 Hrs** |

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|---|---|---|
| **Unit II:** | **Characterization Techniques for Inorganic Nanomaterials**<br>A] Applications of X-Ray diffraction: Index reflections, Identifications of unit cell from systematic absences in diffraction pattern, Structure of simple lattices and X-Ray intensities.<br>B] Principle instrumentation and application of electron spectroscopy for chemical analysis (ESCA), transmission electron microscopy (TEM), HRTEM, Scanning electron microscopy (SEM), FESEM, EDAX, Probe Microscopy (STM & AFM), UV-Visible-NIR spectroscopy (optical microscopy), FTIR, BET, surface profiler, Electro chemical work station. | **15 Hrs** |
| **Unit III:** | **Applications of Nanomaterials**<br>Carbon nanomaterials, Nanocomposites including metal nanomaterials such as single particle as well as coreshell nanomaterials, Fuel cell, Solar cell, Medicinal applications, Agro-food applications, Polymer Nanotechnology, Organic electronics, Nanotribology and Nanobiotechnology. | **15 Hrs** |
| **Unit IV:** | **Nanotoxicity and Biosafety**<br>Introduction to Nanotoxicology, Nanoetymology, Nanotoxicology challenges, Physicochemical characteristic dependent toxicology, Epidemiological evidences, Mechanism of nanotoxicity, Assessment of nanomaterial toxicity: In vitro toxicity assessment-cell viability and in vivo toxicity assessment. | **15 Hrs** |

**Reference Books:**


1. The Chemistry of Nanomaterials edited by C.N.R. Rao, A. Muller, A.K. Cheetham Wiley VCH Verlag GmbH & co. Volumes 1 & 2.
2. Nanomaterials by Dr. Sulbha Kulkarni.

3. T. Pradeep, “A Textbook of Nanoscience and Nanotechnology”, Tata McGraw Hill Education Pvt. Ltd., 2012
4. Hari Singh Nalwa, “Nanostructured Materials and Nanotechnology”, Academic Press, 2008
5. Handbook of Nanotoxicology, Nanomedicine and Stem Cell Use in Toxicology. Saura C Sahu, Daniel A Casciano
6. Nanomaterials and Nanochemistry, 2007, Catherine Brechignac, Philippe Houdy, Marcel Lahmani, ISBN 978-3-540-72992-1 Springer Berlin Heidelberg New York.
7. Nanomaterials Chemistry, Recent Developments and New Directions C.N.R. Rao, A. Muller, and A.K. Cheetham, ISBN 978-3-527-31664-9, 2007 WILEY-VCH Verlag GmbH and Co. KGaA, Weinheim.
8. Nano-Surface Chemistry, 2001, Morton Rosoff, ISBN: 0-8247-0254-9, Marcel Dekker Inc. New York.
9. Principles of Instrumentals Analysis: D. Skoog & West

## M. Sc. Part - II (Inorganic Chemistry) Semester – IV
## DSE - XII: Elective Paper II: Energy and Environmental Chemistry (DSE15CHE42)

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**Course Outcomes: After the completion of the course the student will be able to:**

**CO1:** Understand the basic building blocks of various forms of energy and to know applications of fuel cells in various sectors, hydrogen production, storage, handling and safety issues.

**CO2:** Understand energy storage systems and to describe the parts in various Li-Ion Battery, materials and functionalities.

**CO3:** Explain the common principles, routes and processes in controlling the gaseous pollutants.

**CO4:** Understand meaning of important parameters for measuring water quality and understand the principles and the practical approaches and technique required to effectively monitor the chemical, hydrological and microbiological elements of water quality.

| Unit No. | Syllabus | No. of Lectures |
|---|---|---|
| **Unit I:** | **Energy Conversion Devices**<br>**A] Fuel Cells:** Working of Fuel Cell, Types of fuel cells, Uses, Fuel cell stacks and systems, Hydrogen fuel cell.<br>**B] Production of Hydrogen:** Electrolysis, Thermochemical processes, Steam Reformer processes, Water gas process, Bosch process, Biosynthesis and photochemical processes, Coal Gasification, Steam Iron processes, Partial Oxidation processes, Storage, Transport and Handling of Hydrogen. | **15 Hrs** |

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|---|---|---|
| **Unit II:** | **Energy Storage Devices (Batteries)**<br>Li ion Batteries: Principle of operation, Battery components and design, electrode material ($LiCoO_2$, $LiNiO_2$, $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$, $LiMn_2O_4$, $LiFePO_4$, graphitic carbon) their synthesis and characterization, Theoretical capacity, Energy density, power density, cycle life, electrode and battery fabrication, battery modules and packs, Li- polymer batteries and applications, Electrolytes for Li-ion batteries, Other solid state batteries, Future developments and beyond lithium batteries: Li-S battery, Li-air battery, Advanced Lead – acid batteries, sodium batteries, Battery Recycling technologies. | **15 Hrs** |
| **Unit III:** | **Air Pollution and Control Methods**<br>Introduction, Source Correction Methods; substitution of raw materials, process modification, existing equipment modification, maintenance of equipment, Control of Particulate emissions, Selection of a particulate collector, Control of gaseous pollutants, NOx and SOx, Removal of $H_2S$, Control of CO-pollution, Control of hydrocarbon emission, Control of pollutant emission from mobile sources. | **15 Hrs** |
| **Unit IV:** | **Water Pollution and Monitoring Control Methods**<br>**A]** Sewage and industrial wastes, COD and BOD, Estimation methods, Toxic heavy metal Analysis of Cd, Hg, As, Pb and Cr metals, Control Methods: Water softening and Municipal water purification<br>**B]** Techniques in environmental analysis – ND-IR , FT- IR, AAS, ICT- AES, GCMS, HPLC, Anodic Stripping, Voltametry etc. | **15 Hrs** |

**References Books:**


1. Fuel Cell Fundamentals, R.O. Hayre, et.al., John Wiley and Sons, 2016
2. Environmental Pollution, A.K. De
3. Environmental Pollution Analysis, S. M. Khopkar
4. Lithium Ion Batteries Materials, Technology and new Applications, K.Ozawa, Wiley.
5. Electronic Waste Magement. , Ed. Ramchandra, CRC Press 2015 1st edition.

# M. Sc. Part - II (Semester - IV) Inorganic Chemistry Practical Course
## DSE – PR-IV: Chemistry Lab - IV
## (DSC15CHE49) (Credits2+2)

**Practical courses include Submission of project work.**

## I] Non-Instrumental Experiments

### A] Analysis of Ores and Alloy (Any One)

1. **Ore Analysis –** Illeminite Ore
2. **Alloy Analysis –** Bronze alloy

## II] Instrumental Major Experiments (Any One)

1. To study the system of $Ni^{2+}$ and ethylenediammine by Job's Variation method Spectrophotometrically.
2. To determine the solubility contact of ferric ammonium sulphate and sulpho-salicylic acid by Job's variation method and slope ratio method and mole ratio method Spectrophotometrically..
3. To determine the formula and stability constant of complex between $CdSO_4$ and $Na_2S_2O_3$ conductometrically

## III] Inorganic Preparations (Any Two)

1. Preparation of [Potassium diaquo dioxalato Chromate(III)]
2. Preparation of [Bisacetylacetonato Copper(II)]
3. Preparation of [Potassium dioxalato cuprate(II)]
4. Synthesis of Nickel Ferrite

## IV] Instrumental Minor Experiments (Any Two)

1. Determination of λmax and 10 Dq for [Bisacetylacetonato Copper(II)] spectrophotometrically.
2. To study the titration of mixture of $H_2SO_4$, $CH_3COOH$ and $CuSO_4.5H_2O$ Vs NaOH conductometrically.
3. To determine the dissociation constant of orthophosphoric acid pH metrically.
4. To determine the pKa value of acetic acid pH metrically.

**Note: Any suitable experiment may be added when required**

**Study tour is compulsory for M.Sc. Part- II Students to visit Chemical Industries in India.**

## RPR-II: RPR15CHE41: Research Project (6 Credits) (150 Marks)

1. The student should submit the final bound dissertation/thesis copy of research work carried out during semester III and IV.
2. It should include title page, certificate, declaration, acknowledgement, abbreviations, index, abstract, introduction, experimental section, results and discussion, conclusions, references, participation in conferences/seminars and publications if any.
3. The students should present their work during the evaluation in the form of power point presentation (PPT).

- **Marking Scheme:**

| Sr. No. | Description | Marks |
|---|---|---|
| 1 | Dissertation/thesis bound copy | 30 |
| 2 | Quality of work ( Innovative concepts, social relevance, extent of work etc.) | 50 |
| 3 | Publications | 20 |
| 4 | Participation in conferences | 10 maximum |
| | a) Oral/Poster Presentation (10 marks) | |
| | b) Only attended (7 marks) | |
| 5 | Final Dissertation/thesis defence | 40 |
| | **Total** | **150** |

**Note**:

The Project will be examined jointly by internal (Project Supervisor) and external examiners (preferably Associate professor and above with Ph. D.) at the end of the semester. The project can be given individually or a maximum group of three students is allowed. (Not more than three students allowed).

**Reference Books:**


1. A Text book of Quantitative Inorganic Analysis; A. I. Vogel
2. Practical inorganic chemistry; Pass Geoffrey and haydn Sutcliffe.
3. Advance Inorganic Analysis – S K Agarwala, KeemtiLal , Pragati Prakashan
4. Advanced Practical inorganic chemistry; Gurudeep Raj.
5. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
6. Systematic experimental physical chemistry – T. K. Chondhekar& S.W. Rajbhoj
7. Experiments in chemistry – D.V. Jahagirdar
8. Textbook of quantitative Inorganic Analysis – IV Edn. J. Bassett, R. C. Denny, G.H. Gefery and J. Mendham

## Scheme of teaching and examination

- The semester examination will be conducted at the end of each term (both theory and practical examination)
- Theory paper will be of 80 marks each and 20 marks for internal evaluation test conducted in the mid of the term. Two practicals will be of 100 marks each.
- Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus.

## Nature of Question Paper and Scheme of Marking

1. There shall be 7 questions carrying 16 marks each.
2. Question No. 1 is compulsory. It consists of fill in the banks, objective or answer in one sentence type questions.
3. The remaining question No. 2 to 7 are divided into two sections (Section I and II).
4. Section I consists of question No 2, 3 and 4.
5. Section II consists of question No 5, 6 and 7.
6. Questions 2 to 6 consists of 2 or 3 sub questions.
7. Question No 7 consists of sub questions in which students have to write short notes on any three or four sub questions among the given options.

# Nature of Question Paper

**M.Sc. (Part-I/II) Semester-I/II/III/IV (CBCS) Examination ……..**

**Name of the Paper (Paper No…..)**

**Sub. Code: ……..**

**Day & Date: _____**

**Time: _____** **Total Marks: 80**

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*Instructions:*
1) *Question one is compulsory.*
2) *Attempt any 'TWO' questions from each section.*
3) *All questions carry equal marks.*
4) *Figures to the right indicate full marks.*
5) *Neat and labelled diagram should be drawn wherever necessary.*

**Q. 1)** **Answer the following. (One mark each)** **[16]**

**SECTION-I**

**Q. 2)** **i.** **[8]**

**ii.** **[4]**

**iii.** **[4]**

**Q. 3)** **i.** **[8]**

**ii.** **[4]**

**iii.** **[4]**

**Q. 4)** **i.** **[8]**

**ii.** **[4]**

**iii.** **[4]**

**SECTION-II**

**Q. 5)** **i.** **[8]**

**ii.** **[4]**

**iii.** **[4]**

**Q. 6)** **i.** **[8]**

**ii.** **[8]**

**Q. 7)** **Write a note on. (any four)** **[16]**

**i.**

**ii.**

**iii.**

**iv.**

**v.**

**vi.**

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

Dr. (Mrs). S, D, Shirke
HEAD
DEPARTMENT OF CHEMISTRY
VIVEKANAND COLLEGE KOLHAPUR
(EMPOWERED AUTONOMOUS)